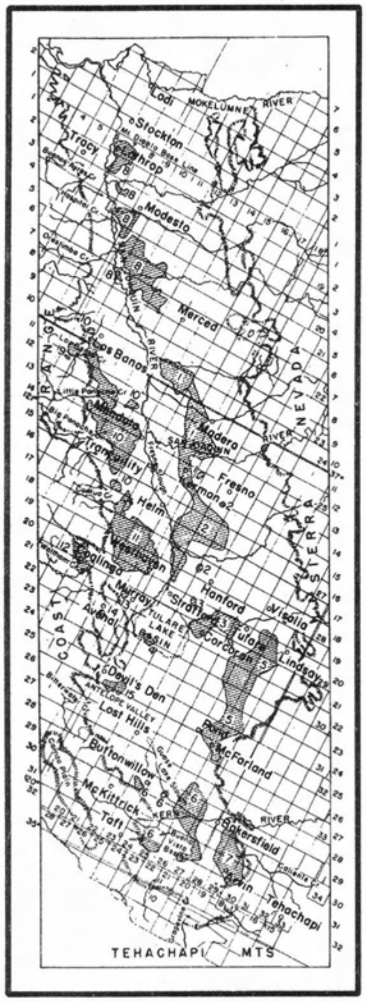
CALIFORNIA PLANT PEST & DISEASE REPORT

California Department of Food & Agriculture
Plant Pest Diagnostics Center
3294 Meadowview Road
Sacramento, California
95832-1448

What's Inside:
Vol. 15 Numbers 5-6
October-December 1996

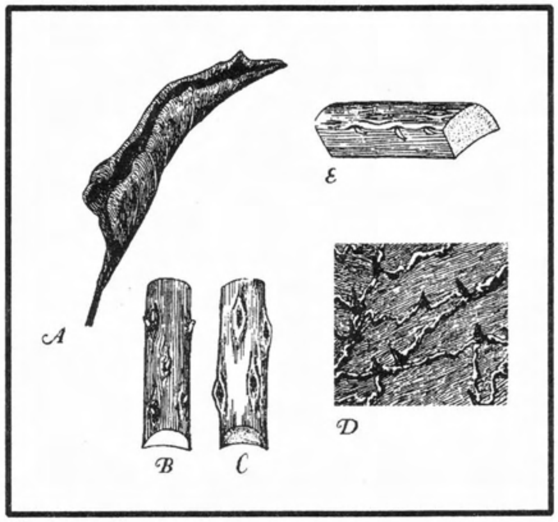
CURLY TOP VIRUS IN CALIFORNIA

Historical Overview & 1996 Annual Report



CIRCA 1943

Russian-thistle localities in San Joaquin Valley - a summer host of beet leafhopper.



CIRCA 1909

Various plant damage caused by the beet leafhopper.

CIRCA 1955

USDA truck applying spray to a weed-host area containing beet leafhoppers.

CALIFORNIA PLANT PEST & DISEASE REPORT

CALIFORNIA PLANT PEST & DISEASE REPORT

Editor: Raymond J. Gill
Production Assistants: Brenda R. Beckwith & Edith M. Barbour

The editor acknowledges the contributions of numerous individuals within this department, without whose cooperation and assistance this project would not be possible.

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Sacramento, CA 95832-1448

The California Plant Pest and Disease Report, Volume 15, Numbers 5-6, was issued on January, 1997 and printed April, 1997.

1909 Ball, E. D. The leafhoppers of the sugar beet and their relation to the "curly-leaf" condition. USDA Entomology Bulletin No. 66(4). [A. Small leaf of sugar beet, showing characteristic "curly-leaf" condition. B. Enlarged section of back of an extreme case of "curly-leaf," showing "warty" condition of veins. C-E. Section of beet stem; showing fresh eggs in place (C), eggs ready to hatch (D), old egg-scars (E). (Author's illustrations.)]

1943 Lawson, F. R. The ecology of the principal summer weed hosts of the beet leafhopper in the San Joaquin Valley, California. USDA Tech. Bulletin No. 848.

1955 Douglass, J. R., Van E. Romney, E. W. Jones. Beet leafhopper control in weed-host areas of Idaho to protect snapbean seed from curly top. USDA Circular No. 960.

ENTOMOLOGY HIGHLIGHTS

ANNUAL REPORTS

PINK BOLLWORM (PBW)
The pink bollworm project, has been included in this issue of the CPPDR as a year end summary of pink bollworm trap catches in the cotton-growing counties of the southern San Joaquin Valley. A report outlining these 1996 trapping efforts, as well as historical data, for pink bollworm in the San Joaquin Valley is located on page 166.

CURLY TOP VIRUS (CTV)
The beet leafhopper/curly top virus control program has been in existence in California at least since 1943. It has not been covered previously in CPPDR. A historical overview and 1996 annual report on curly top virus and its insect vector, beet leafhopper, are found on pages 171 and 177, respectively.

SIGNIFICANT FINDS

AFRICANIZED HONEY BEE (AHB), *Apis* "Africanized," -(A)- On November 9, Hodgkin found this pest in a tree in Calexico, **Imperial** County. Also in Imperial County, D. Papilli found these bees on *Rhapis* sp. in Seeley on November 14. See the "New County Records" section of this issue for information on the important discovery of Africanized honey bee in **San Diego** County. Also, a map showing the first 38 finds, including the two stinging incidents, is included on page 159. Eradication treatments will be applied.

GYPSY MOTH, *Lymantria dispar*, -(A)- Gypsy moth was also found in just two counties during this period. Mark Lubinski discovered this pest on a doghouse on October 16. This find was in Crescent City, **Del Norte** County. The next three finds for November 13 were all made in Penn Valley, **Nevada** County. Jimenez found a gypsy moth on a boat trailer. Finds by Sawyer and Lubinski were on the walls of houses. These finds do not represent infestations.

JAPANESE BEETLE, *Popillia japonica*, -(A)- Only one Japanese beetle was trapped in the last part of the year. Myers made the find on December 23 in Oakland, **Alameda** County. This find does not represent an infestation.

ORIENTAL FRUIT FLY, *Bactrocera dorsalis*, -(A)- Four Oriental fruit flies were discovered in Jackson traps between October and December, 1996. Two were found in **Los Angeles** County, one in Alhambra and one in Brentwood. The Alhambra find was made by Tran on grapefruit on October 9. The Brentwood find was made by Martin on orange on November 11. On October 4, Stevenson found an Oriental fruit fly on peach in Ontario, **San Bernardino** County. Finally, K. Cutler discovered this fruit fly in Union City, **Alameda** County, on November 5. These significant finds do not represent established infestations. Subsequent high density trapping determined that these finds do not represent infestations.

APPLE MAGGOT, *Rhagoletis pomonella*, -(B)- An apple maggot was collected by R. Spadoni from a trap in Fortuna, **Humboldt** County, on November 12. This find is well within the area previously determined to be infested.

TWO SPOTTED LEAFHOPPER, *Sophonia rufofascia*, -(Q)- Two spotted leafhopper was found in Encinitas, **San Diego** County on November 8. D. Kellum made this important find on *Sollya heterophylla*. This pest had been detected previously at the San Diego Zoo by Bernarr Kumashiro, Hawaii Department of Agriculture, who was visiting the zoo while on vacation in March, 1996. Two spotted leafhopper has been found in nurseries in Los Angeles and Santa Barbara counties. See the "Exclusion" section of this issue for recent nursery finds of this pest in two Los Angeles nurseries. For more information, including a fact sheet and illustrations, on two spotted leafhopper, see CPPDR 15(1-2):4-5,6-7.

HOT OFF THE PRESSES

The latest scale book from Ray Gill has just been printed and is available at the address printed on the inside cover of the CPPDR. Part 1, The Soft Scales, and Part 2, The Minor Families, are also available at this address.

THE SCALE INSECTS OF CALIFORNIA
PART 3
THE ARMORED SCALES

(Homoptera:Diaspididae)

by:
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California Department of Food and Agriculture
Sacramento, California, USA

1997

NEW STATE RECORDS

CORN FLIES, *Megaselia seticauda* and *Euxesta stigmatias*, -(Q)- Two flies (Diptera) that are potentially significant pests of corn (*Zea mays*) have been detected in California for the first time. These species are *Megaselia seticauda* (Malloch) (Phoridae - scuttle flies) and *Euxesta stigmatias* Loew, (Otitidae - picture-winged flies). Both species were found together in a field of sweet corn in **Riverside** County. Because both flies have been previously implicated together in causing economic damage in corn, they are discussed jointly in the following report prepared by Eric Fisher, Associate Insect Biosystematist, Plant Pest Diagnostics Center.

Megaselia seticauda (Cob Fly; Family Phoridae)

Dr. Eldon Reeves, Riverside County entomologist, reported on October 29 that fly larvae had destroyed about 85% of one acre of green sweet corn in San Jacinto. He noted that these larvae were seen feeding directly on fresh kernels in the ears, but that much of the infested portion of the ear was rotting. Specimens of larvae submitted by Dr. Reeves to Dr. Eric Fisher of CDFA's Plant Pest Diagnostics Center, proved to be a species of scuttle fly. This was thought to be an unusual finding, as these flies are not generally considered to be plant pests.

A few days later adults were submitted and identified as belonging to the very large phorid genus, *Megaselia*. These specimens looked quite similar to *Megaselia scalaris*, a very common, world-wide scavenger species. A search of the literature on this species uncovered a 1951 report on damage to sweet corn in Texas. This report indicated that together *M. scalaris* and *Euxesta stigmatias* had become such severe pests to sweet corn in the Rio Grande Valley region of Texas that late season production of this crop was discontinued. Authors of this report gave these flies the common names of "cob fly" and "corn silk fly."

However, as critical examination of the Riverside flies showed differences from *M. scalaris* specimens in the CDFA reference collection, samples were sent to Dr. Brian Brown, a world authority on scuttle flies and Curator of Entomology at the Natural History Museum of Los Angeles County. Dr. Brown reported back that this fly was *Megaselia seticauda*, a species that has the same color pattern and general appearance of *M. scalaris*. He also noted that it had been recorded from corn in records from Mexico and Ecuador. Knowing that the Texas specimens of *M. "scalaris"* were identified by U.S. National Museum (USNM) personnel, Dr. Brown searched for and found vouchers for this record among scuttle flies he had borrowed from that institution. These voucher specimens proved also to be *M. seticauda* - showing that just this single species of scuttle fly is now known as a pest of corn (and hence is properly entitled to the name cob fly).

Almost nothing has been published on this species of scuttle fly. It is evidently widespread in Mexico, Central and South America, with additional findings in Texas and now California. Although evidence exists that this species does primary damage to corn, it may benefit from (or even need) the additional presence of a decay organism (fungus) to provide an optimum environment for feeding (fungi are the basic food of the vast majority of scuttle fly species). Up to nearly one hundred larvae of cob flies were found in individual infested corn ears.

Euxesta stigmatias (Corn Silk Fly; Family Otitidae)

Six additional species of flies were also submitted from the infested corn by Dr. Reeves. Most of these were identified as well-known, widespread scavenger species. However, one species of Otitidae proved to be *Euxesta stigmatias*, one of the several species of *Euxesta* that are known as pests of corn in Latin America, and a new record for California. Although literature from tropical America indicates that at least four species of *Euxesta* are primary pests in corn, this information has not been widely reported in U.S. publications on Diptera pests. The earlier-mentioned occurrence in Texas, plus a recent series of papers on the fly from Florida, are the exceptions.

The corn silk fly also has a wide distribution, occurring nearly throughout Mexico, Central and South America. It is also common in the Caribbean and evidently has become established in Florida and Texas. It definitely is a primary feeder in corn. Although often found in moldy parts of corn ears (with cob flies and other species), field observations and experiments in Florida show that this fly has the ability to consume entirely fresh kernels. Female flies oviposit among silks (tassels) at tips of ears (up to eight females per ear; green corn, one to three weeks after tasseling, is considered optimal. Larvae begin feeding on silks, then move to kernels; if abundant, they may spread throughout the ear. Damage to the corn ear is not apparent from outside inspection alone, as the silks and sheath cover the area of the feeding larvae. Pupation may occur either in the ear or in the ground. Development from egg to adult takes between 18 (Puerto Rico) to 35 days (Florida); climate and host availability permitting, many generations per year are possible. Both sweet corn and seed or field corn are susceptible but sweet corn apparently is preferred by the fly. Development time averages a couple of days shorter in sweet corn. Sorghum (*Sorghum bicolor*) is also a good host for *Euxesta stigmatias* in Florida. Other crops (sugar cane, guava, banana) occasionally harbor this fly but are not considered to be hosts.

Euxesta stigmatias causes up to 95% loss of sweet corn crops, in the absence of control efforts, in Florida. No insecticides that effectively control this pest are thought to be currently registered.

Associated Fungal Rot

Fusarium moniliforme (corn ear rot) was identified by Tim Tidwell, Plant Pathologist, Plant Pest Diagnostics Center, as the cause of decay in the corn ears submitted by Dr. Reeves. Certain bacteria - "fast growing, secondary forms" - were also identified (by Dr. Dan Opgenorth, Plant Pest Diagnostics Center), but these are thought to be incidental to the main damage in the corn ears.

Corn ear rot is common in fields wherever corn is grown. It is thought to take advantage of the feeding wounds of corn pest insects (corn earworm, *Helicoverpa zea*, is a known culprit) by allowing easy entry to kernels inside the protective outer sheath. *Euxesta stigmatias* also provides entry pathways for this fungus. Corn earworm damage was evident on some of the ears submitted to our lab.

The interaction of the flies (and other insects) with the Fusarium fungus needs to be further investigated - if a proper understanding of the ecology of this corn pest complex is to be gained.

NEW CALIFORNIA FAUNAL RECORDS

Nomenclatural Changes and Some Newly Described Genera and Species of California Thrips

Work done by Steve Nakahara, thrips and whitefly specialist at the USDA Systematic Entomology Laboratory in Beltsville, Maryland, has resulted in several publications that deal with part of the thrips fauna (Thysanoptera) in California. The newly described species covered here are very likely native to California and the southwestern United States and northwestern Mexico. Thus, they are not necessarily new state records; rather they are new additions to the California Thysanopteran fauna.

In one paper (Nakahara, 1995a) a new genus, *Ewartithrips*, containing 6 species, was described from California. This new genus contains four newly described California species and two species which were reassigned from the old genus *Taeniothrips*. These six species are found on a large number of native plants in numerous families. They are not known to be of economic importance. The following list indicates the new species in *Ewartithrips* and current synonymies of the others:

Ewartithrips californicus Nakahara.
Ewartithrips dispar Nakahara.
Ewartithrips ehrhornii (Moulton), formerly in the genera *Euthrips*, *Physothrips*, *Taeniothrips* and *Tenothrips*.
Ewartithrips flavidus Nakahara.
Ewartithrips longirostrum (Jones), formerly in the genera *Euthrips*, *Physothrips*, *Taeniothrips* and *Mycterothrips*.
Ewartithrips salviae Nakahara.

In the second paper (Nakahara, 1996), the new monotypic genus and species *Xerothrips dissimilis* was described. The species is known from the Mojave Desert of California and Nevada, and from the Central Valley of California. More specifically, it is known from the California counties of Kern, Yolo, Tulare, Lake, and Madera, and from Nye County, Nevada. It has been collected from *Eriastrum densifolium* (phlox family), grasses, *Quercus agrifolia*, *Vitis* and *Tillandsia*. So far, it is rarely collected and is not known to be a pest. It is considered a native species, but the strange occurrence on *Tillandsia* in a Madera County greenhouse is very intriguing. Taxonomically it is most closely related to the genera *Baileyothrips*, *Oxythrips*, *Pseudothrips* and *Taeniothrips*.

In the third paper (Nakahara, 1995b), a revision is made of the entire genus of the Nearctic *Anaphothrips*. With species distributed over most of the world, this genus is comprised primarily of grass-feeding thrips . As a result of the revision by Nakahara and by others, the genus has been split up and drastically re-aligned. In the work by Bailey, 1957, eight California species were listed. Now, only one species remains in the genus, the European introduction *Anaphothrips obscurus*.

The following list indicates the other original California *Anaphothrips* and their current placements:

Anaphothrips longipennis = *Proscirtothrips zeae* (Moulton) 1911.
Anaphothrips minutus = *Baileyothrips arizonensis* (Morgan) 1913.
Anaphothrips orchidii = *Chaetanaphothrips orchidii* (Morgan)1907.
Anaphothrips reticulatus = *Prosopoanaphothrips reticulatus* (Moulton) 1907.
Anaphothrips secticornis = *Apterothrips secticornis* (Trybom) 1896.
Anaphothrips stanfordii = *Apterothrips stanfordii* (Moulton) 1907.
Anaphothrips tricolor = *Odontanaphothrips tricolor* (Moulton) 1911.

References:

Bailey, S.F. 1957. The thrips of California Part 1: Suborder Terebrantia. Bull. Calif. Insect Surv. 4(5):1-220.
Nakahara, Sueo. 1995. *Ewartithrips* new genus (Thysanoptera:Thripidae) and four new species from California. J. New York Entomological Society. 103(3):229-250.
---- 1995b. Review of the Nearctic species of *Anaphothrips* (Thysanoptera:Thripidae). Insecta Mundi. 9(3-4):221-248.
---- 1996. *Xerothrips dissimilis* new genus and species (Thysanoptera:Thripidae) from California and Nevada. Proc. Entomol. Soc. Wash. 98(2):208-214.

JASMINE WHITEFLY, *Aleurotuberculatus jasmini*, -(Q)- Jasmine whitefly was found in California for the first time on October 26. C. Rendon and N. Nisson made this important discovery in Irvine, **Orange** County. This new pest was found on *Jasminum sambac*. Feaster made a subsequent find on *Jasminum nitidum* in Irvine on December 5.

The jasmine whitefly, *Aleuroclava jasmini* (Takahashi), was originally described in 1932 in the genus *Aleurotuberculatus*, from Taikoku, Taiwan. It is known from China, Hong Kong, Taiwan, Thailand and Malaysia, and was introduced into Hawaii several years ago. It has been recorded from various plant families including Combretaceae, Euphorbiaceae, Myrsinaceae, Oleaceae, Rubiaceae and Rutaceae. Even though the favored host is jasmine, the genera *Gardenia*, *Citrus*, *Bischofia*, *Osmanthus* and *Murraya* are among the other recorded hosts.

Although this initial find is in a nursery, we are considering the species to be established. The population was heavy, and the plants have been in California a long time. If they were brought in from out-of-state, their origin is unknown. It is also not known what impact this species will have in California. Nothing has been published about its economics in other parts of the world. The morphology of jasmine whitefly is illustrated on the following page.

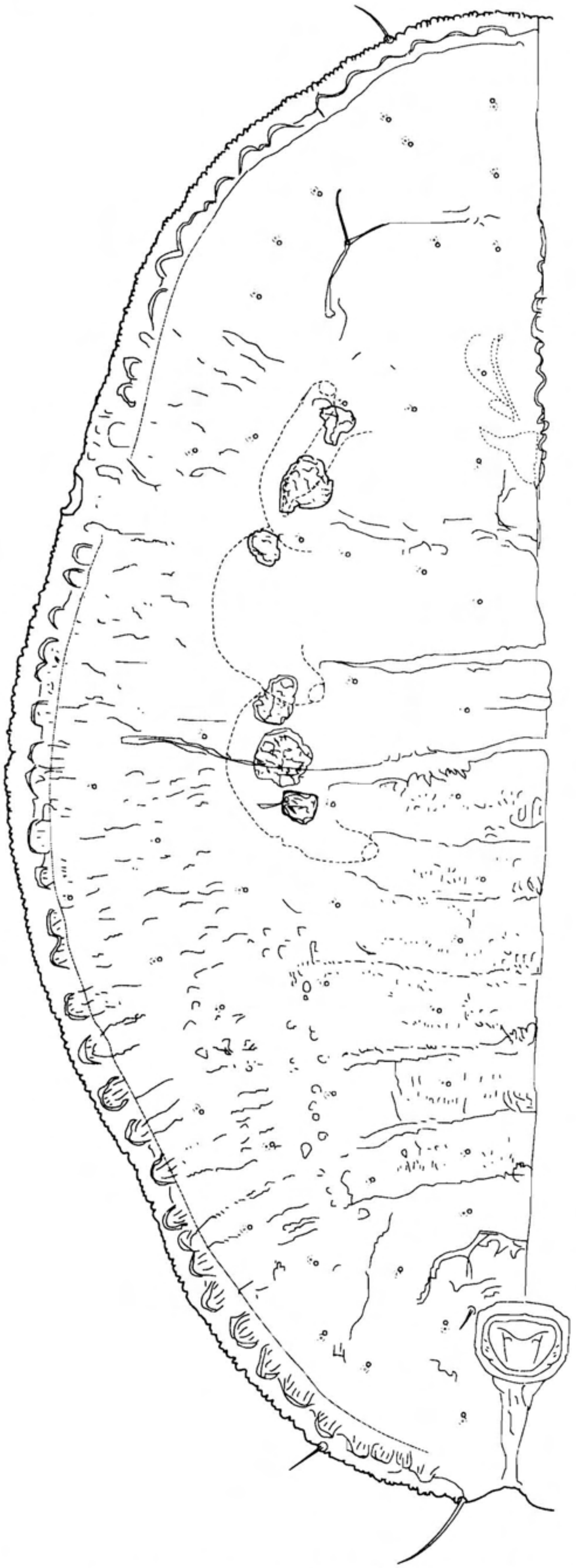


Fig. 1: Morphology of 4th instar nymph (pupa), *Aleurotuberculatus jasmini*; Left side dorsal, right side ventral. Ventral features are dashed lines.

NEW COUNTY RECORDS

AFRICANIZED HONEY BEE (AHB), *Apis* "Africanized," -(A)- Back in June of this year, Africanized honey bees were found for the first time in **San Diego** County. This is the farthest west that these bees have been discovered in the United States. Dr. Walter Boyce collected the bees from a miscellaneous sweeping around a Borrego Springs watering hole. A map showing the distribution of Africanized honey bee in California is located on the next page. Each AHB find is numbered and dated under its location. The shaded area represents the general locality where Africanized honey bees are being found within the state.

SWEET POTATO WEEVIL, *Cylas formicarius elegantulus*, -(A)- Sweetpotato weevil has been found for the first time in **San Diego** County. The initial discovery was on December 5 in San Diego. David Kellum, San DiegoCounty Entomologist, made this imporant find on sweet potatoes. The next find came when a home gardener in Encanto submitted a sample to the San Diego County Agricultural Commissioner's Office on December 20. CDFA staff in San Diego County found the remaining tubers in the harvested 1/4 acre field to be heavily infested with larvae and adults. Two hundred and forty pounds of stored sweet potatoes within the storage area of the property were confiscated and destroyed. The field plot was rototilled twice and the remaining tubers that were found were removed and also destroyed. The plot was secured with plastic tarps and the soil sterilized through solarization, an accepted form of treatment for this pest. Further survey of all other sweet potato growing sites within the county and the deployment of traps at other selected areas was initiated to delimit the infestation.

Subsequent finds were reported from San Diego on December 21 and 23 by Neville and Taylor, respectively. Since the beginning of the new year over one hundred finds have been made from San Diego, Bonita, Spring Valley, National City, and Lemon Grove. Ultimately, a 225 sq. mile area north of the Mexican border was trapped at varying rates. The Division of Plant Industry, CDFA, maintains a quarantine against this pest to protect the $63 million sweet potato business that is centered in the Merced/Stanislaus counties area of California. The growers helped fund an eradication program that was successfully completed two years ago. California produced 9,600 acres of sweetpotatoes in 1996. San Diego County is a very minor production area. For more information on sweetpotato weevil, see CPPDR 12(1-2):3-8.

A THRIPS, *Scirtothrips* sp., -(Q)- This new thrips was initially recorded in the first 1996 issue of the CPPDR(15:1-2). After its discovery in Ventura County over the summer, it has subsequently been found in two more adjacent counties. The first find was in Santa Maria, **San Luis Obispo** County, by R. Little and J. Davidson. Like the original collection, t hey found the pest infecting avocados on October 1. On October 22, J. Davidson then found the same thrips on avocados in Carpinteria, **Santa Barbara** County.

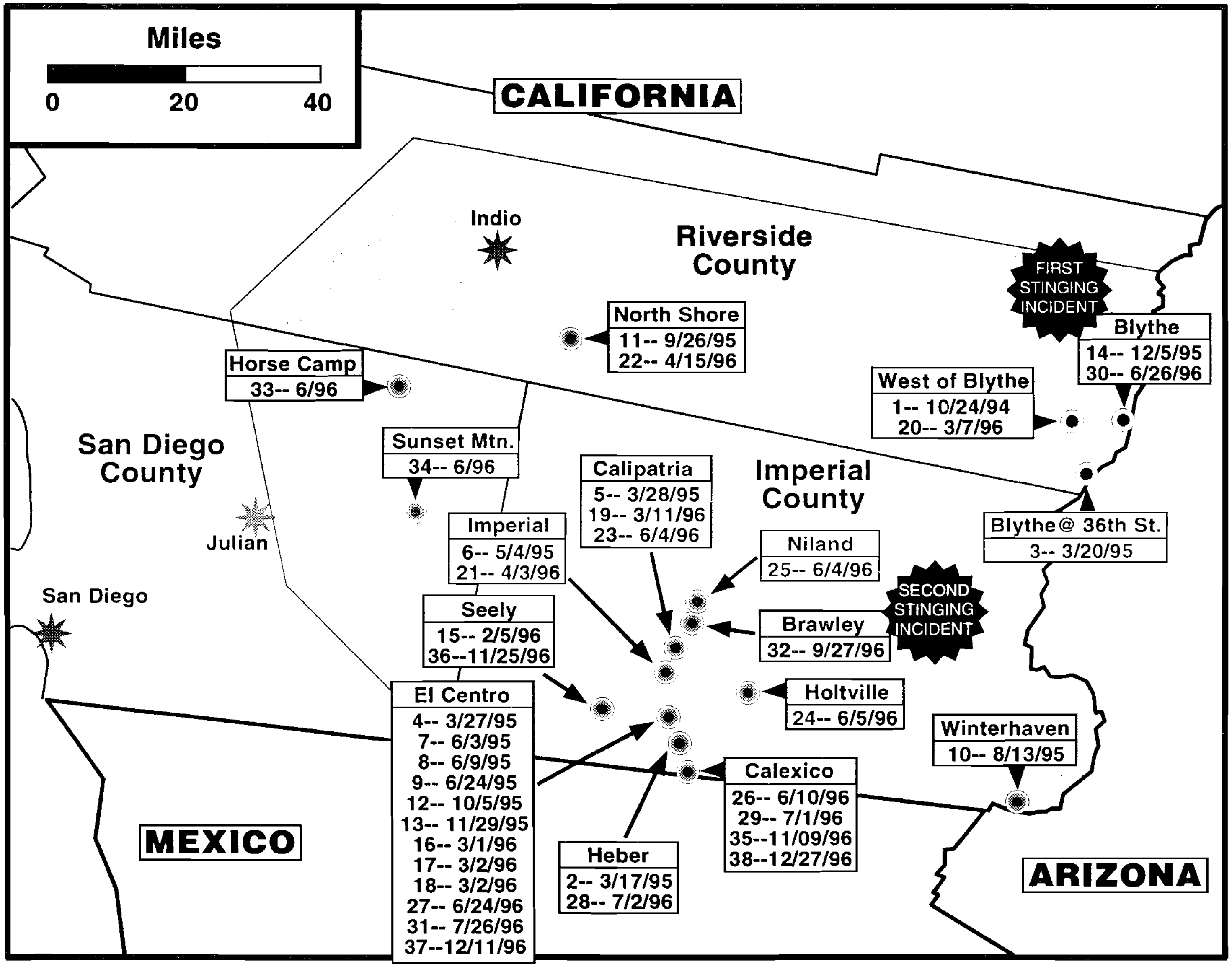
HAWAIIAN FLOWER THRIPS, *Thrips hawaiiensis*, -(Q)- On October 10, Hawaiian flower thrips was discovered for the first time in Irvine, **Orange** County. Tiffer found this pest on *Gardenia* sp. Nick Nisson then found the same pest on gardenia on October 23, also in Irvine.

LEUCAENA PSYLLID, *Heteropsylla cubana*, -(Q)- A leucaena psyllid was discovered by Dan Papilli on November 7on *Leucaena* sp. The new county record was in Whittier, **Los Angeles** County.

NESTING WHITEFLY, *Paraleyrodes minei*, -(C)- This pest was found for the first time in Berkeley, **Alameda** County, on November 11. R. Blumenthal made the find on *Laurus nobilis*.

Africanized Honey Bee in California

DISTRIBUTION AS OF 31 DECEMBER 1996



EXCLUSION

The following "A," "B," & "Q" rated insects have been found infesting nursery stock or in other quarantine situations in California during the last part of 1996. The pest list on page 163 represents some of the more unusual finds intercepted in quarantine.

TWO SPOTTED LEAFHOPPER, *Sophonia rufofascia*, -(Q)- Two significant finds of two spotted leafhopper were made in San Gabriel nurseries, **Los Angeles** County. On October 23, Michael Sium discovered two spotted leafhopper on *Tristania* at one nursery. Then, on November 8, Sium found this pest on *Psidium guajava* at another nursery.

SLENDER SOFT SCALE, *Coccus acutissimus*, -(Q)- Dan Papilli found this scale at a nursery in Whittier, **Los Angeles** County. The find, on *Euphoria longan*, was made on November 6.

BROWN CITRUS APHID (BCA), *Toxoptera citricida*, -(Q)- A report on the brown citrus aphid was published in the CPPDR [11(1-2):11-14], but insects have been found since then on unexpected hosts and there is quite a bit of concern about this. While the specimen was most recently detected on a plant from Hawaii, plants from Florida must be carefully inspected as well. The department has learned that brown citrus aphid has recently been intercepted on *Cordyline* and *Anthurium* nursery stock shipped via FedEx from a nursery in Hawaii into **Orange** County, California.

We are requesting that the border stations and the counties continue to carefully inspect any potential BCA host plants coming from Hawaii or Florida, two states where this insect is known to occur, and reject any shipments confirmed to be infested with this pest. Reported hosts of BCA, in addition to citrus and other members of the Rutaceae, include cotton, cotoneaster, hawthorn, apple, pear, spirea, *Ficus* species, Japanese persimmon, sumac, mango, passion flower and azalea. In addition, it is important to inspect plant material of any species that could potentially harbor this pest.

While feeding damage is a serious concern, a greater threat is its documented ability to act as an efficient vector of citrus tristeza virus complex, the most economically important virus pathogen of citrus worldwide, causing "quick decline" and severe stem-pitting of susceptible trees. Although well established in Hawaii, this aphid species was first detected on the mainland in November, 1995, on an orange tree in Fort Lauderdale, Florida, during fruit fly trap inspections.

BCA is slightly larger than other aphid species that feed on citrus. It is usually found in large, dark brown populations on new growth, located mainly on leaf mid-rib and green stem areas. One reported field diagnostic tool is to crush suspect aphids; apparently squashed BCA leaves a tell-tale red residue behind.

Clearly, tristeza is one of the most destructive citrus diseases today. The International Organization of Citrus Virologists (IOCV) was created after tristeza destroyed millions upon millions of trees between the 1930's and the 1950's. This severe global threat is of significant interest to people around the world.

The following report on the basic biology of the citrus tristeza virus was presented by Richard Lee at the "Workshop on Citrus Tristeza Virus/*Toxoptera citricida*, in Central America and the Caribbean Basin," held at CATIE, Turrialba, Costa Rica in May, 1991:

> Citrus tristeza virus is a member of the closterovirus group. It is the largest reported plant virus and has a flexuous rod shape about 11 X 2,000 nm in size. The virus particle contains a plus-sense RNA of about 6.6 million daltons size. The phloem-limited virus forms inclusion bodies which can be seen with the light microscope. Double-stranded (as) RNAs can be extracted and purified from virus-infected plants, these include a full length replicative form of about 13.3 million daltons plus several "subgenomic" dsRNAs. The virus is transmitted semipersistently by several aphid species, the most efficient vector being *Toxoptera citricida*. The virus is spread also through infected budwood.

There are other aphids that occur on citrus in California that could be confused with either of these aphids in the field and so field identification of aphids on citrus should not be relied on. All local agricultural officials should be on the lookout for this pest and carefully examine host plants for this insect. Submit a generous sample in an alcohol vile and get some winged forms if at all possible.

In the laboratory, however, slide mounted specimens of the two Toxoptera species can be separated readily from all other California aphids. The undersides of the abdomen (roughly in the area directly under the cornicles) have a series of striations which are used for sound production via stridulation. Associated with these striations on the abdomen are the corresponding stridulatory pegs found on the inner sides of the hind tibiae. The stridulatory mechanisms are unique to the genus *Toxoptera*.

The brown citrus aphid differs from the common black citrus aphid, *Toxoptera aurantii*, by five primary characteristics. Color alone is not sufficient to discriminate between them. If one is able to see the winged form of both aphids on the same leaf or plant, the four primary characteristics that differentiate them are the following:

1. Relative size -- *T. citricida* is 10% larger.
2. The dark 3rd segment of the antennae of the winged form of *T. citricida* compared to the lighter 3rd segment for *T. aurantii*.
3. The distinctly lighter pterostigma wing area in *T. citricida* as compared to the very dark segment for *T. aurantii*.
4. The median or middle vein is conspicuously forked in *T. citricida*, but is not forked in *T. aurantii*.
5. *T. citricida* has 10-20 scattered sensoria on antennal segment III and 2-4 setae on antennal segment IV, compared to the absence of sensoria on antennal segment IV and 6-8 sensoria in a line on segment III in *T. aurantii*.

The morphological illustrations on the next page illustrate the general morphology of both *T. aurantii* and *T. citricida* and the stridulatory devices which are characteristic of the genus *Toxoptera*. There are numerous species of *Toxoptera* in other parts of the world, and the included information is meant only to separate *T. aurantii* from *T. citricida*.

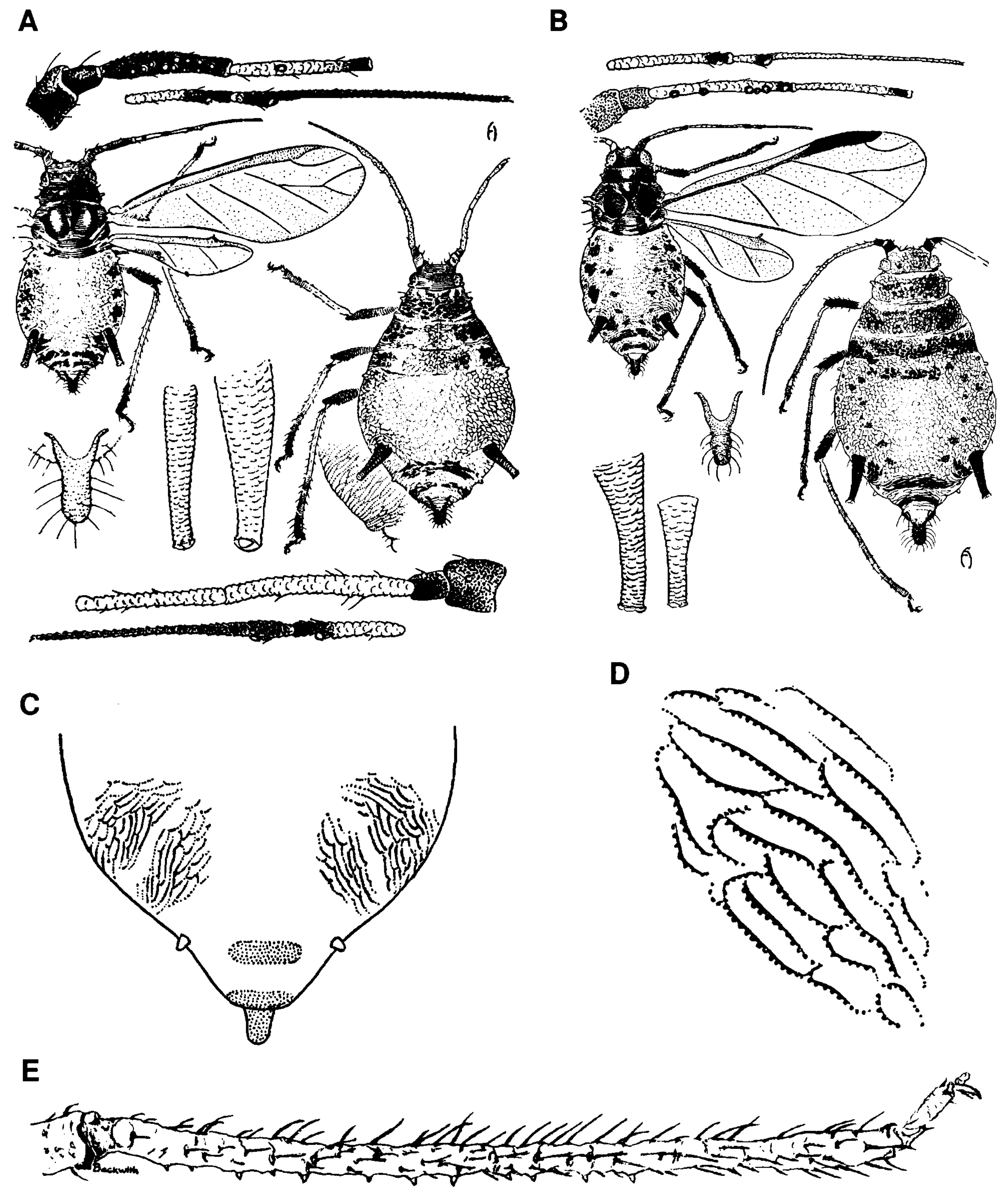


Fig. 2. Morphological characteristics of *Toxoptera*: A. Adult morphology of *T. citricida*. B. Adult morphology of *T. aurantii*. C. Ventral view of abdomen of *T. aurantii* showing positions of the stridulating striations. D. Enlargement of the abdominal stridulation areas of *T. aurantii*. E. Hind tibia of *T. aurantii* showing the arrangement of the stridulatory pegs. Illustrations A to D taken from Essig, 1949, Pan-Pacific Entomologist 25(1):13-23.

"A", "B", and "Q" Rated Arthropods and Mollusks Intercepted in Quarantine
October 1996 - December 1996

Rating	Species	Common Name	Date	Origin	County	Host	Collector(s)
B	*Zabrotes* sp.	a bruchid beetle	10/03/96	Costa Rica ?	SJQ	---	Linden
Q	*Enchenopa binotata*	twomarked treehopper	10/04/96	Michigan	SJQ	*Celastrus scandens*	Park
Q	*Ceroplastes floridensis*	Florida wax scale	10/08/96	Florida	ORA	---	Lanchester
A	*Ceroplastes rubens*	red wax scale	10/08/96	Florida	SJQ	*Schefflera arboricola*	Lanchester
A	*Hemiberlesia palmae*	tropical palm scale	10/08/96	Florida	SBA	bromeliad	Trupe
B	*Protopulvinaria pyriformis*	pyriform scale	10/08/96	Florida	SJQ	---	Lanchester
Q	*Hylastes ater*	a bark beetle	10/10/96	New Zealand	ALA	*Pinus radiata*	Olmsted
A	*Bactrocera dorsalis*	Oriental fruit fly	10/14/96	Hawaii	SMT	*Psidium* sp.	Garibaldi
Q	*Ceroplastes rusci*	fig wax scale	10/16/96	Florida	SJQ	*Ravenea rivularis*	Lansigan
Q	*Orchamoplatus mammaeferus*	croton whitefly	10/17/96	---	ORA	*Alyxia olivaeformis*	Fernandez
A	*Bactrocera dorsalis*	Oriental fruit fly	10/23/96	Hawaii	SMT	*Psidium* sp.	Garibaldi
A	*Pseudaulacaspis cockerelli*	magnolia white scale	10/24/96	Hawaii	ORA	*Alyxia olivaeformis*	Fernandez
A	*Ceroplastes rubens*	red wax scale	10/25/96	Hawaii	LAX	cut flowers	Dias
Q	*Chilo* sp.	a pyralid moth	---	Hawaii	PLA	flowers	Yamamoto
B	*Ferrisia virgata*	striped mealybug	10/30/96	Costa Rica	SJQ	*Codiaeum* sp.	Pelletier
Q	*Orchidophilus* sp.	a weevil	10/31/96	Hawaii	LAX	orchid	Bakri
Q	*Chrysodeixis eriosoma*	green garden looper	11/02/96	Hawaii	LAX	*Ocimum basilium*	Awad
Q	*Aleurotrachelus* sp.	a whitefly	11/04/96	Hawaii	LAX	*Piper betle*	Chinwah
Q	*Gyponana germari*	a leafhopper	11/04/96	Hawaii	LAX	herbs	Chinwah
Q	*Paleocallidium rufipenne*	a longhorned beetle	11/05/96	Korea/Belgium	ALA	dunnage	Olmsted
A	*Cylas formicarius elegantu*	sweetpotato weevil	11/08/96	---	ALA	*Ipomoea batatas*	Eaton
Q	*Incisitermes* sp.	a drywood termite	11/08/96	Florida	SMT	*Rhizophora mangle*	Pendleton
Q	Tortricidae	a leafroller	11/08/96	---	ALA	*Ipomoea batatas*	Eaton
B	*Diaphania nitidalis*	pickleworm	11/12/96	Florida	SMT	*Cucumis sativus*	Loux
Q	*Anoplolepis longipes*	longlegged ant	11/14/96	Hawaii	LAX	*Rhapis* sp.	Papilli
Q	*Rhizoecus hibisci*	a root mealybug	11/14/96	Hawaii	LAX	*Rhapis* sp.	Papilli
Q	Noctuidae	a noctuid moth	11/18/96	Florida	SAC	cut tree fern	Bianchi
Q	*Cedusa* sp.	a planthopper	11/19/96	Hawaii	SJQ	---	Pelletier
A	*Cylas formicarius elegantu*	sweetpotato weevil	11/20/96	---	SFO	*Ipomoea batatas*	Copenheaver
A	*Coccus viridis*	green scale	11/22/96	---	ALA	*Citrus hystrix*	Eaton
Q	*Aleurocerus* sp.	a palm whitefly	12/03/96	Mexico	SMT	commador palm	Loux
B	*Ferrisia virgata*	striped mealybug	12/03/96	Guatemala	SJQ	---	Pelletier
Q	*Hemiberlesia diffinis*	diffinis scale	12/03/96	Florida	ORA	*Ficus benjamina*	Fernandez
Q	Margarodidae	margarodid scales	12/03/96	Mexico	SMT	commador palm	Loux
A	*Ceroplastes rubens*	red wax scale	12/04/96	Hawaii	SJQ	*Strelitzia* sp.	Pelletier
B	*Dasineura balsamicola*	balsam fir gall midge	12/06/96	Maine	MEN	*Abies balsamea*	Nelson
B	*Diaphania nitidalis*	pickleworm	12/10/96	Florida	SMT	squash	Loux
B	*Parlatoria pergandii*	chaff scale	12/11/96	Florida	HUM	*Citrus* sp.	Haggard

BORDER STATIONS

Over the years we have featured some of the interesting pest interceptions at the California Plant Inspection Stations (Border Stations) strategically placed along highways leading into the state in each issue of the CPPDR. These stations are part of the first line of defense against the introduction of new agricultural pest species in the state. The stations started operating a long time ago to small amounts of traffic. Current day traffic levels are phenominal. We do not wish to reproduce here the weekly reports generated by border station officials on traffic load and pest interceptions, but our intent is to highlight the important role played by the stations and the people that operate them.

It has been called to our attention by one of our readers that charts we produce on border station finds include only a two letter abbreviation of the border station name. To rectify that problem we are including a map showing the approximate location and the full name of each California station on the next page. The following table outlines a few of the discoveries made by border station personnel over a two week period:

Pest	Station	Date	Origin	Collector	Host
Boll weevil - *Anthonomus grandis*	LO	10/01	Mississippi	Doyle	Florida auto
	NE	10/11	Arkansas	Urquidi	California auto
	NE	10/15	Texas	Mangin	Texas auto
White-marked tussock moth - *Orgyia leucostigma*	NE	10/11	Pennsylvania	Martinez	RV chassis
European corn borer - *Ostrinia nubilalis*	NE	10/12	Kansas	Friedman	corn
	LO	10/22	Iowa	Sheppard	ear corn
Hickory shuckworm - *Cydia caryana*	WI	10/17	Texas	Clay	pecan husks
	LO	10/23	Mississippi	Sheppard	pecan husks
Pecan weevil - *Curculio caryae*	WI	10/17	Texas	Clay	pecans
	YE	10/19	Texas	Blakely	pecans
	LO	10/23	Mississippi	Sheppard	pecans
May beetle - *Phyllophaga* sp.	WI	10/18	Virginia	Rocha	grapefruit
A weevil - *Anthonomus* sp.	NE	10/19	Missouri	Mangin	pecans?
Gypsy moth - *Lymantria dispar*	LO	10/19	New York	Wildschut	RV chassis
Zebra mussel - *Dreissena polymorpha*	TR	10/20	Michigan	Rudolph	sailboat
	TR	10/21	Michigan	Rudolph	Jet ski hoist
Pink bollworm - *Pectinophora gossypiella*	WI	10/20	Alabama	Ebers	cotton plants
Knapweed - *Centaurea* sp.	YE	10/23	Canada	Wright	floral
Eastern tent caterpillar - *Malacosoma americanum*	LO	10/26	Virginia	Hamblet	RV trailer

TALES FROM THE BORDER

Needles Station

The sugar glider rejected at this border station was an Australian marsupial which looks rather like a flying squirrel with webbed front legs. This animal, reportedly purchased in Florida for $500, was surrendered for disposal by the travelers who were in too big a hurry to bother taking it out-of-state.

California Border Stations

★ Headquarters-Sacramento

Permanent Stations

- BE-Benton
- BL-Blythe
- DO-Dorris
- HO-Hornbrook
- LO-Long Valley
- ME-Meyers
- NE-Needles
- RE-Redwood Highway
- SM-Smith River
- TR-Truckee
- TU-Tulelake
- VI-Vidal
- WI-Winterhaven
- YE-Yermo

Permanent Stations (Modified Operations)

- AL-Alturas
- TO-Topaz

PINK BOLLWORM (PBW) ACTIVITIES 1996 ANNUAL REPORT

Rodney A. Clark, CDFA

Early detection trapping (one trap per 20 acres of cotton) in the San Joaquin Valley was conducted from April 22 through June 29, at sites having 1995 native catches, to detect possible overwintering populations. No PBW natives were trapped. General trapping activities (one trap per sixty acres) began June 1. The total number of traps deployed during the peak of the season was 19,325. Traps are inspected weekly through October 24, and were removed by October 31. A special desert trap line runs from Hwy. 58 into the Mojave Desert, along Hwy. 138, and back into the San Joaquin Valley. This trap line monitors possible PBW moth migration from the cotton growing regions of Riverside and Imperial counties into the San Joaquin Valley. One non-sterile PBW moth was caught on the special desert trap line at the south end of the San Joaquin Valley, at a truck stop off Hwy 99. Most likely, this moth was a "hitchhiker," not a "blow-in." Only one trap in the Mojave Desert caught any moths this season. Within the San Joaquin Valley, trap-catches of blow-in and/or hitchhiker moths from other cotton growing regions (southern California, western Arizona, and northern Mexico) usually begin in late September. Moths trapped in the Valley in 1996 did not appear to be the result of "blow-ins." Catches of native moths along highways 5 and 90, and at several tourist/truck stops, appeared to be "hitchhikers."

A grand total of 1,208,910 acres of cotton was mapped in California during 1996. Southern California cotton acreage totaled 20,005 acres. The six cotton growing counties of northern California's Sacramento Valley had a total of 5,760 acres. Pink Bollworm (PBW) Program personnel mapped 1,183,145 acres of cotton in the six counties of the San Joaquin Valley. This acreage is down from the 1,263,992 acres mapped in 1995. Pima cotton plantings in 1996 amounted to 165,965 acres, up sharply from 129,761 acres in 1995.

Sterile pink bollworm moths are produced in the department's PBW Phoenix, Arizona, rearing facility. Almost one billion moths were released over a maximum area of a little more than 105,000 acres in the San Joaquin Valley.

The pink bollworm Identification (ID) Lab in Visalia examined 48,881 traps containing suspect moths submitted by trappers. A total of 1,416,714 sterile moths and 201 native moths were identified in these San Joaquin Valley traps.

Native Pink Bollworm Finds
San Joaquin Valley

Year	Fresno	Kern	Kings	Madera	Merced	Tulare	Total	Larvae	Desert	First-Last Find Date
1996	22	75	25	3	30	46	201	0	1	7/9-11/4
1995	11	49	12	0	9	32	113	0	5	6/27-10/27
1994	25	113	11	1	5	46	201	0	18	7/6-10/26
1993	3	30	4	0	1	13	51	0	0	7/6-10/27
1992	21	68	7	1	8	10	115	0	0	5/18-10/28
1991	79	151	16	1	0	16	263	0	26	7/18-10/24
1990	108	1,588	59	7	18	1,459	3,239	300+	43	6/25-11/9
1989	20	121	11	2	2	10	166	0	3	6/21-10/25
1988	70	265	282	10	9	255	891	0	4	7/26-10/26
1987	71	116	66	3	0	38	294	0	0	7/1-11/10
1986	3	42	5	1	0	11	62	0	0	6/23-10/29
1985	87	39	6	1	7	20	160	0	0	6/25-11/5
1984	3	305	7	0	3	33	351	0	49	5/9-11/6
1983	18	761	45	2	6	31	863	4	68	6/7-10/27
1982	13	87	8	3	6	3	120	0	8	7/22-10/28
1981	18	576	36	0	0	47	677	0	3,050	5/28-11/4
1980	354	1,504	465	0	2	2,167	4,492	9	0	6/30-11/24
1979	15	489	29	20	4	197	754	0	0	8/13-11/2
1978	4	22	8	1	2	32	69	0	0	7/13-11/1
1977	25	6,058	50	0	0	1,269	7,402	4	0	6/24-11/11
1976	3	1,260	19	0	0	192	1,474	0	0	6/16-11/16
1975	5	180	3	0	3	54	245	0	0	7/2-11/18
1974	1	374	5	1	0	56	437	0	503	7/3-11/19
1973	0	25	0	0	0	0	25	0	0	8/13-10/1
1972	0	31	0	0	0	5	36	0	0	8/3-11/7
1971	1	3	0	0	0	8	12	0	0	8/5-11/18
1970	0	13	0	0	0	0	13	3	0	7/17-11/12
1969	0	5	0	0	0	0	5	0	0	9/8-10/20
1968	0	0	0	0	0	0	0	0	0	none
1967	0	4	0	0	0	0	4	3	0	10/2-11/9

Cotton Acreage
San Joaquin Valley

Year	Fresno	Kern	Kings	Madera	Merced	Stanislaus	Tulare	Total Cotton Acre.	Pima Cotton Acre.
1996	401,370	293,750	251,680	38,365	87,490	55	110,435	1,183,145	165,965
1995	398,487	309,850	285,630	44,997	85,985	55	138,988	1,263,992	129,761
1994	372,476	292,152	269,395	46,240	78,675		139,845	1,198,783	75,960
1993	371,675	295,200	261,815	50,400	82,447		144,620	1,206,157	94,874
1992	352,553	288,555	254,805	48,706	78,330		143,185	1,166,134	127,947
1991	342,947	249,242	233,825	52,722	79,520		145,705	1,103,961	63,455
1990	369,025	315,256	247,455	45,520	67,200		139,775	1,118,423	
1989	349,955	301,050	235,175	44,275	60,205		137,030	1,127,690	
1988	427,329	351,677	294,125	51,160	73,275		170,830	1,368,396	Desert
1987	382,350	310,980	262,915	44,920	62,625		148,205	1,211,995	(Cantil)
1986	331,035	284,315	229,750	40,794	50,550		124,315	1,060,759	Cotton
1985	421,208	342,068	304,790	48,514	63,665		156,160	1,336,405	Acreage
1984	433,780	383,010	281,360	49,360	63,400	San Benito	181,280	1,392,190	(no pima)
1983	322,794	294,445	210,905	26,985	34,637	215	115,315	1,005,296	180
1982	412,615	376,005	282,655	49,572	52,183	830	152,470	1,326,330	2,560
1981	451,337	426,830	287,235	49,620	66,670	1,075	168,340	1,451,107	3,000
1980	435,249	443,160	285,695	55,211	66,692	722	176,680	1,463,409	
1979	484,087	459,620	298,630	78,923	84,172	843	218,845	1,625,120	
1978	420,001	442,840	289,240	63,840	69,409	1,264	214,145	1,500,739	
1977	364,914	394,400	248,900	63,138	70,878	1,144	209,830	1,353,204	
1976	334,901	341,444	219,430	40,005	51,186	872	142,879	1,130,717	
1975	271,693	286,397	167,300	26,618	35,340	310	98,307	885,965	
1974								1,275,070	
1973								983,783	
1972								896,000	
1971								unknown	
1970								unknown	
1969								unknown	
1968								unknown	
1967								548,400	1,400

Pink Bollworm Program Statistics
San Joaquin Valley

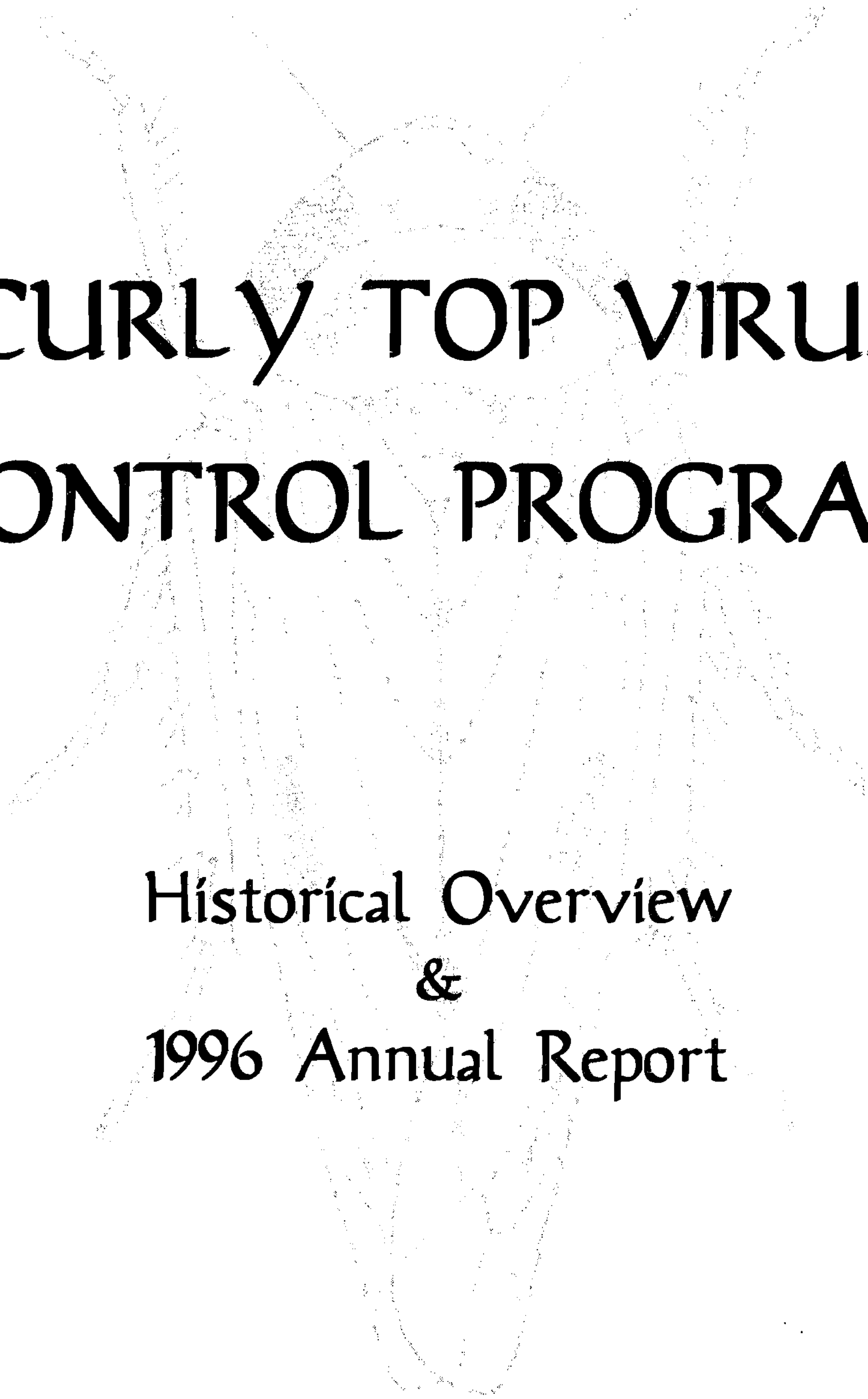
Year	Trapping Start	Trapping End	No. of Traps	Lure Type	Trap Type	Trap Ratio	Service Interval	Pheromone Treated Acres Base Ac.	Pheromone Treated Acres Total Ac.	Acres
1996	4/22	10/31	19,325	Consep	Delta	1/60 VW	Weekly	0	0	0
1995	4/24	10/24	20,849	Consep	Delta	1/60 VW	Weekly	0	0	0
1994	4/25	10/26	19,869	Consep	Delta	1/60 VW	Weekly	0	0	0
1993	4/26	10/28	20,007	Consep	Delta	+ 1/20 ES	Weekly	0	0	0
1992	4/27	10/22	19,438	Consep	Delta	+ 1/20 ES	Weekly	0	0	0
1991	4/22	10/24	18,300	Consep	Delta	+ 1/20 ES	Weekly	2,065	10,545	0
1990	4/23	10/25	19,093	Consep	Delta	+ 1/20 ES	Weekly	1,680	7,280	280X2
1989	4/23	10/26	19,160	Consep	Delta	+ 1/20 ES	Weekly	0	0	0
1988	4/25	10/27	22,653	Gos/Sep	Delta	+ 1/20 ES	Weekly	1,210	3,570	0
1987	6/1	10/30	19,916	Gos/Sep	Delta	+ 1/20 ES	Weekly	1,400	3,173	0
1986	6/2	10/30	13,287	Gos/Sep	Delta	1/80 VW	Weekly	0	0	0
1985	6/3	11/6	17,159	Gos/Sep	Delta	1/80 VW	Weekly	590	1,130	0
1984	6/6	11/8	17,621	Gos/Sep	Delta	1/80 VW	Weekly	1,780	5,340	
1983	6/13	10/28	12,850	Gos/Sep	Delta	1/80 VW	Weekly	500	1,500	
1982	6/1	10/29	16,933	Gos/Sep	Delta	1/80 VW	Weekly	0	0	
1981	6/1	11/10	19,390	Gossy/	Delta	1/80 VW	Weekly	0	0	
1980	6/2	10/31	20,809	Sand	Delta	1/80 VW	Weekly	2,571	7,714	
1979	6/4	11/2	20,591	Sand	Delta	1/80 VW	Weekly			
1978	6/5	11/3	19,606	Sand	Delta	1/80 VW	Weekly			
1977	6/6	11/11	33,711	Sand	Delta	1/40 VW	Weekly			
1976	6/1	11/13	27,449	Sand	Delta	1/40 VW	Weekly			
1975	6/16	11/14	22,047	Sand	Delta	*	Weekly			
1974	6/17	11/19	32,280	Hex/GL	Frick	*	Weekly			
1973	6/18	11/16	49,311	Hex	Frick	*	Bi-Weekly			
1972	6/5	11/15	46,000	Hex	Frick	*	Bi-Weekly			
1971	4/5	11/19	86,000	Hex	Frick	*	Weekly			
1970	4/6	11/25	4,000	Hex	Frick	*	Weekly			
1969	4/11	11/25	5,850	Hex	Frick	*				
1968	4/5	11/27	2,100	Hex	Frick	*				
1967	5/16	11/30	1,020	Hex	Frick	*	2*/wk			

VW=Valley Wide
HH=High Hazard
*=See USDA Data Sheet

Sterile Moth Release Program
San Joaquin Valley

Date Begin	Aerial End	Moths Released	Moths Recovered	Recovery Ratio	Acres Start	Acres Released Over Max	Acres Released Over End
5/7/96	10/11	911,633,624	1,416,714	644 :1	78,936	105,170	87,330
5/31/95	10/13	484,563,915	677,050	716:1	13,060	66,380	45,687
5/9/94	10/14	915,483,074	1,581,371	579:1	69,690	100,307	100,307
5/11/93	10/15	833,388,722	1,460,285	571:1	25,200	65,067	65,067
5/12/92	10/16	702,545,374	1,742,495	403:1	63,800	68,700	30,755
5/14/91	10/18	812,971,230	3,733,208	218:1	25,110	140,438	114,993
5/6/90	10/12	701,501,964	1,911,655	367:1	48,450	129,220	98,685
5/16/89	10/21	763,203,596	2,478,856	305:1	84,285	102,356	79,000
5/17/88	10/21	754,876,477	1,188,335	629:1	180,370	180,380	70,850
5/19/87	10/23	670,070,000	1,057,925	609:1	223,360	223,360	62,719
5/13/86	10/24	660,350,000	352,821	1651:1	30,145	82,560	44,231
5/14/85	10/25	483,740,000	434,739	1209:1	41,235		59,228
5/15/84	10/26	571,500,000	2,144,018	260:1	85,487		42,876
5/17/83	10/28	586,770,000	1,057,735	555:1	109,375		131,811
5/10/82	10/29	772,120,000	1,041,280	714:1	138,254		146,805
5/13/81	10/30	794,260,000	864,861	918:1	200,000		352,773
5/20/80	10/31	510,490,000	566,170	902:1	210,000		177,230
5/2/79	11/2	636,980,000	545,295	1169:1	101,650		253,559
5/2/78	11/3	455,990,000	429,063	1063:1	400,000		354,518
5/3/77	11/15	412,170,000	1,677,900	246:1	200,000		400,000
5/11/76	11/13	193,640,000	1,229,742	158:1	116,000		90,450
5/8/75	11/15	150,110,000	1,529,260	98:1	61,500		116,612
6/5/74	11/16	87,010,000	282,897	307:1	79,000		101,185
5/15/73	11/16	89,770,000	37,656	2362:1	79,000		79,490
5/27/72	11/10	99,130,000	59,080	1680:1	89,630		117,265
5/3/71	11/16	108,270,000	11,159	9843:1	60,000		89,630
4/15/70	11/25	99,720,000	26,428	3835:1	60,000		60,800
5/5/69	11/25	8,213,600	564	14557:1	21,345		21,345
5/9/68	11/25	9,170,000	20	458500:1	14,500		14,500

CURLY TOP VIRUS CONTROL PROGRAM



Historical Overview & 1996 Annual Report

HISTORICAL OVERVIEW

Rodney A. Clark, CDFA

INTRODUCTION

Curly top virus (CTV) is a viral disease of sugar beets, tomatoes, peppers, beans, cucumbers, squash, pumpkins, spinach, vine seed and other commercially important crops, but at times it devastates backyard vegetable and flower gardens. The only known vector of CTV is *Circulifer tenellus* (Baker), commonly known as the sugar beet leafhopper (BLH).

Control of BLH may take place at various locations throughout the Antelope, Cuyama, Imperial, Salinas, and San Joaquin valleys which include portions of Fresno, Imperial, Kern, Kings, Los Angeles, Merced, Monterey, Riverside, San Benito, San Joaquin, San Luis Obispo, Santa Barbara, and Stanislaus counties.

The size of the control program is totally dependent on the location, size and distribution of the BLH population. In years with below normal rainfall, BLH populations can be large and widespread. In periods of drought (successive years of below normal rainfall), the Curly Top Virus Control Program (CTVCP) has observed a reduction in rangeland vegetation and a corresponding decline in BLH populations which reduced the need for treatment.

In a year with a low population, only 80,000 acres or fewer, in western Fresno, Kings and Kern counties may require treatment. In years with below normal rainfall, the treatment required may increase to more than 200,000 acres and may include acreage in several inter-coastal valleys, including the Cuyama and Salinas valleys.

Not all areas require treatment on an annual basis. The mode and probability of treatment varies within the potential treatment area. The CTVCP supported research which developed an antiserum allowing the use of Enzyme-Linked Immunosorbent Assay to determine the presence, on a percentage basis, of CTV in the BLH population. Thus, the amount of virus found in a given area lends weight to treatment priorities.

PURPOSE

The purpose of the CTVCP is to prevent agricultural crop damage as a result of CTV infection. Without the control BLH, CTV would threaten well over three billion dollars of susceptible crops and home gardens.

With only a 1% loss from CTV in California, it is estimated that during the period 1974-1976, California suffered annual losses of $9.75 million in commercial crops alone. A $2.68 million loss in home gardens can be extrapolated from a 1974 value of $268,199, 643 using a 1% infection rate (Yokomi 1979). Without control where required, BLH is capable of causing an infection rate of 10-40% or more. Infection rates as high as 80% were observed near Huron, California, in 1977.

BACKGROUND

A brief review of the Program's history and development will aid in understanding the purpose and objectives of the CTVCP.

In the early part of the 20th century, large areas in California and the western United States were cleared of natural vegetation to plant grain. In succeeding years, price fluctuation led to either alternative crop use or abandonment of much of this land. At the same time, unrestricted grazing of cattle and sheep denuded what was once lush grazing land. The result has been an enormous increase in areas ideal for BLH reproduction where natural vegetation was replaced by mustards, *Brassica* sp., Russian thistle, *Salsola* sp. and other annual BLH host plants. A study by Piemeisel and Chamberlain (1936) found well managed grazing land does not produce economically important numbers of BLH.

BLH is a desert insect introduced from the Middle East, probably in the late 1800's. Years with below normal precipitation provide favorable environmental conditions for the insect, causing CTV to be devastating to the agricultural economy. The year 1919 was such a year and nearly ended the then young sugar beet industry in California. Out of the near disaster of 1919 emerged a concerted effort by private, state and federal researchers to design control methods that would minimize CTV incidence. After extensive research over a period of several years, it was found that in California, BLH migrated between the valleys and the foothills and at times concentrated on particular host plants (Severin 1933). It was apparent that once breeding grounds and migration patterns were determined, control efforts could be economically carried out with a minimum of expense.

Control was originally carried out by the sugar companies until the realization that a number of other important crops were susceptible to infection and severe losses. As the other crops, such as tomatoes, melons, and beans, increased in acreage, growers found control work becoming futile because of the migratory nature of BLH and the fact that the main breeding grounds were in uncultivated foothill areas under the control of disinterested parties. Private growers and industry could not pursue the insect into the breeding grounds where control was most effective.

In 1943, the State of California, Department of Food and Agriculture, assumed full responsibility for the control of BLH. In the first years, the annual control budget was only $15,000; however, as the effectiveness and cost of the Program increased, the State Legislature enacted a law requiring grower assessments totaling 65% of the budget. The Program is now 100% funded by individual grower assessments.

Were it not for the Program's effective control of BLH and the support of the affected industries, the state and nation would lose a substantial portion of its tomato, sugar beet, melon, bean, squash, pumpkin, cucumber, pepper and spinach crops valued in excess of $1.2 billion annually.

GENERAL PROGRAM

The CTVCP represents an overall strategy for the control of the BLH statewide where the infection of susceptible crops and backyard gardens is likely. Control is performed within rangeland habitat on both public and private lands and along ditch banks, roadsides and fallow fields in cultivation adjacent to rangeland.

The total acres treated in any given year varies depending on rainfall patterns and BLH density and may occur at any location within the potential treatment areas mapped.

Throughout California, the BLH population builds up and disperses at various times of the year, carrying CTV from weed hosts to cultivated crops. Control is a year round effort. As with most pest insects, control is linked to the life cycle and directed at disrupting its continuity. Aerial treatments are employed to control BLH populations in rangeland habitat and in large cultivated fallow fields.

<u>San Joaquin Valley</u> In the San Joaquin Valley, the CTVCP usually conducts three aerial campaigns annually which closely coincide with the reproductive biology of BLH. The winter, spring and fall control periods in the San Joaquin Valley are performed on the west side and southern end of the Valley and are generally performed within three separate geographical areas. A single treatment per calendar year for any given area is generally sufficient to control BLH populations. A second San Joaquin Valley treatment per calendar year over the same geographic area may be necessary to control BLH populations if:

1) fall populations of BLH are developing on Russian thistle on rangelands previously treated in the spring, or;

2) late spring rains rejuvenate drying rangeland vegetation and a second generation of BLH develops on rangeland treated earlier in the spring. Late spring rains have historically developed a second spring generation of BLH in the San Joaquin Valley every five or six years involving an estimated 1,000 to 10,000 acres of rangeland.

<u>Imperial Valley</u> In the Imperial Valley, the CTVCP conducts a single aerial treatment when necessary, in the winter or spring, depending on weather patterns. Historically, treatments in the Imperial Valley are necessary one out of every three years. The treatment acreage varies from 100 to several thousand acres and the specific locations receiving treatments vary from treatment period to treatment period. Many years may pass between treatments to any specific location. A second treatment per calendar year over the same geographical area, due to additional rain, has <u>never</u> been necessary and is <u>not</u> anticipated in the future.

<u>Salinas Valley</u> Historically, aerial treatments in the Salinas Valley are infrequent and have been performed as needed, during the spring once every 7-10 years. The last aerial treatment was performed in the Salinas Valley during the spring of 1977.

While aerial treatments are employed to control BLH populations in rangeland habitat and large fallow fields, ground-rigs are used to control BLH populations along roadsides or ditch banks within cultivated areas adjacent to rangeland breeding grounds. On rare occasions, ground-rigs are used to treat BLH populations in small cultivated fallow fields too small or isolated to be economically treated by aircraft.

A ground-rig is typically a four-wheel drive pickup truck with an engine powered blower in the bed. Insecticide is injected into the air stream of the blower nozzle which is movable. The blower is equipped with dripless nozzles and electric cutoff for precise control of spray. All controls are inside the cab where the operator can start and stop the blower engine, turn the spray off and on and control the direction of the blower. The malathion is mixed in a 100-gallon tank mounted in the bed of the truck and applied at the same rate as an aerial application. The ground-rig vehicles are driven on roads accessible by agricultural vehicles and equipment.

The size and locations of ground-rig treatments in cultivated areas are related to the size and location of BLH populations in adjacent rangeland habitat. One treatment per year is generally sufficient to control BLH populations on roadsides and ditch bank weed hosts.

Ground-rig Only The CTVCP employees use ground-rigs to control BLH populations in five distinct control areas. These areas are designated "ground-rig only" and include the Cuyama Valley, Palmdale-Lancaster, Blythe and Hemet control areas and a portion of western San Joaquin, Stanislaus and Merced counties.

PROGRAM SPECIFICS

Fall control operations in the San Joaquin Valley are the culmination of monitoring the BLH population on Russian thistle (*Salsola* sp.). Beginning in June, Russian thistle is mapped where it is growing on fallow ground, oil fields or rangeland. Maps are updated weekly and the BLH populations are monitored with sweep net surveys. By mid to late September, the Russian thistle harboring the largest populations of BLH have begun. The overwintering generation will be the adults that migrate from the Russian thistle to the hills on the west side of San Joaquin Valley to seek out sunny, south-facing slopes on which they produce the spring generation of BLH. A percentage of the overwintering BLH carry CTV to winter annuals where the disease multiplies and is carried back to cultivated crops by the spring generation of BLH. The only differences between the spring and winter treatments are the time of the year and the phase of the life cycle of the BLH that is targeted. In winter, the adult female is targeted prior to egg deposition, whereas spring operations target adults and nymphs of the first spring generation.

Once the CTVCP personnel, entomologist and agricultural pest control specialists (APCS) determine that the probability of achieving maximum population reduction is high, pre-treatment counts of the BLH population are made and control operations are started.

BLH control is accomplished by insecticidal application. Malathion is mixed with buffered water at a rate of 7.7 oz. of 95% malathion in 120.3 oz. of water equaling one gallon, which is applied to each acre treated. Malathion is routinely sampled by the Chemistry Laboratory, CDFA, to assure quality and absence of contaminants.

Aircraft are used to apply malathion in 100 ft. swaths. A sophisticated GPS system on the contractor's aircraft keeps application swaths in perfect alignment. Most treatments are done with fixed wing aircraft. Supervisors are in constant contact with the pilot to give directions as needed.

Concentrated malathion and water are transported to the aircraft loading site as near to the control area as practical. Mixing is accomplished by metering water, buffered to a pH of 6.5 into a mix tank, then metering the prescribed ratio of malathion into the mix tank under agitation. The aircraft is loaded by connecting a hose with a drip proof connector between the mix tank and the aircraft. Each load transferred to the aircraft is metered and checked against the known area treated to assure proper application rate. The aircraft spray boom system is calibrated under the supervision of the CDFA supervisor on site before application is started and periodically rechecked during the course of the operation.

The aircraft and pilots are under contract to CDFA and meet or exceed all FAA standards. In addition, CDFA requires that the pilot, licensed as a journeyman agricultural pilot, has a minimum of 1000 hours in the type and model of aircraft being used.

Within 72 hours after application is completed in an area, post-treatment checks are made to assure adequate de-population of BLH has been achieved.

Both pre- and post-treatment surveys in Russian thistle are conducted by using a heavy duty sweep net with shallow net bag of CTVCP design. The net frame consists of a 15" round hoop constructed of 3/16" steel attached to a hardwood handle 7/8" round by 25" long. During survey, the net is vigorously swung horizontally in order to contact the Russian thistle plant in such a manner as to enter the foliage several inches and sweep through with sufficient velocity to dislodge BLH and collect them in the attached net bag. The bag is 16" deep and 15" in diameter, constructed to form a shallow cone. Once captured, the BLH begin migrating from the base of the net towards the open top where they are counted as they attempt to exit.

BLH counts are averaged by the number of BLH per net sweep. The single net sweep method is directly related to actual counts from enclosed trap studies conducted over several decades.

If, during an actual pre-treatment survey, counts on Russian thistle averaged 100 BLH per net sweep and post-treatment counts taken 72 hours after treatment averaged three BLH per net sweep in the same area, the population is considered to have been reduced by 97%. A 97% reduction is considered excellent control since malathion at 7.7 oz. per acre cannot fully penetrate the canopy of moderately sized (24"-30") Russian thistle plants. However, most treatments result in a 90th percentile plus mortality because of BLH movement to the outer perimeter of the plants where contact with the malathion is assured.

Survey of BLH populations in winter/spring is a slightly different operation in that the host plants are small, usually only an inch or so above ground and normally on south-facing slopes. A different net sweeping technique is used. The net bag is the same but the 15" flexible hoop is made of flat stainless steel attached to a 30" handle. In sweeping, the net is held against the ground and swiftly moved in a horizontal area of approximately 150° from side to side. As it passes over the tops of host plants, BLH attempting to escape are caught in the cone of the net. Both pre- and post-treatment surveys are conducted and daily evaluations of populations are made in order to alert growers of susceptible crops as to the threat level posed by CTV infection in various areas.

ANNUAL REPORT
1996

Rodney A. Clark, CDFA

Curly top virus (CTV) is an extremely serious plant virus affecting several hundred varieties of ornamental and commercial crops in California. The only known vector of this virus is the sugar beet leafhopper, *Circulifer tenellus* (Baker).

CTV is highly destructive to commercially produced sugar beets, tomatoes, peppers, cucumbers, muskmelons, watermelon, squash, pumpkins, green and dry beans, spinach and varieties of vine seed. Because of the threat to commercial crops, the growers of susceptible crops contribute 100% of the funds necessary to control CTV in California. CTV also infects backyard gardens upon which many people in California depend to provide fresh table vegetables.

The beet leafhopper (BLH) is both resident and migratory. Populations develop in selected habitats within the San Joaquin, Imperial, Sacramento and Intracoastal Valleys of California as well as moving into California from contiguous states and Mexico.

The Curly Top Virus Control Program's (CTVCP) objective is to reduce the incidence of CTV infection in susceptible crops below a level of economic importance, through the use of integrated pest management techniques.

The Program utilizes intensive survey to locate and monitor BLH populations throughout the year. Once the populations are located, they are evaluated as to the amount of virus, potential for migration to susceptible crops in the area and feasibility of control versus natural mortality due to parasites, predators or weather trends affecting host plants.

The general pest control strategy developed by the CTVCP is to:

1. Reduce the potential number of overwintering female BLH through the use of insecticide on selective Russian thistle stands in the early fall.
2. Further reduce surviving gravid overwintering BLH females, prior to egg deposition, once they have concentrated on winter host plants.
3. Selectively treat areas of habitat where a spring population has developed, to prevent migration to crops during late spring and early summer.

The goals of the CTVCP for 1996 were:

- Monitor and selectively suppress overwintering female BLH populations on winter host plants prior to egg deposition.
- Locate, monitor, and selectively suppress the spring hatch of BLH prior to maturation and migration into susceptible crops.

- Assess Program success by surveying susceptible crops for CTV.
- Map all Russian thistle acreage and suppress high BLH populations prior to dispersal to overwintering areas.
- Continue to support and solicit research which will improve control, including the pursuit of identifying biological control agents that would enable the Program to use less insecticide while maintaining CTV damage below economic levels.

During 1996, a total of 69,500 acres was treated aerially during three separate treatment campaigns. Each treatment campaign is described below:

WINTER CONTROL PROGRAM

A total of 7,872 acres of rangeland was treated between February 2-8, 1996, on the west side of Fresno County in the vicinity of Coalinga. The first half of the campaign was hampered by wind and rain leaving unpaved roads inaccessible to survey and spray vehicles. The weather improved during the second half of the campaign which allowed the majority of malathion treatments to be completed during the last three days.

The first BLH egg parasites released in 1996 were distributed between two locations during the winter treatment campaign. *Gonatocerus* sp. and *Polynema* sp. were released on the Coalinga Nose and along Warthan Creek, in the vicinity of Coalinga.

SPRING CONTROL PROGRAM

Approximately 47,203 acres of rangeland was treated in Kern, Kings, Fresno and Merced Counties to control BLH from April 4-16, 1996. Treatment activities were initiated in Kern County where a single crew completed treatments in three days. Treatment activities resumed immediately after Easter as two crews utilized both a fixed-wing aircraft and a helicopter to treat the remaining rangeland breeding grounds in Kings, Fresno and Merced Counties. For maximum efficiency, the fixed-winged aircraft was employed to treat BLH habitat along continuous ridges from Cantua Creek to Manning Avenue and in the Kettleman Hills. The helicopter was used to treat the smaller, fragmented pieces of rangeland in Big and Little Panoche Canyons and on the Coalinga Nose. The most rapidly drying rangeland vegetation was given treatment priority as varying rates of drying were evident throughout the entire treatment area.

As in past years, the weather impacted the rate at which treatment activities were performed. High winds were responsible for reducing the treatment acreage on April 10, 12, and 16, 1996.

Above normal temperatures prior to Easter accelerated the drying of rangeland vegetation in many historical BLH breeding sites. BLH populations were observed initially in sparse peppergrass and filaree on south-facing slopes. By the end of the treatment campaign the BLH population was migrating to green filaree and *Plantago* vegetation on the north-facing slopes.

Acertagallia leafhoppers were found in large concentrations this year. As in the spring of 1993, *Acertagallia* leafhoppers outnumbered BLH's 10 to 1 in prime BLH habitat. Large grasshopper populations were routinely observed in rangeland vegetation from Kern to Merced County. The majority of the grasshopper population was comprised of second and third instar nymphs.

FALL CONTROL PROGRAM

A total of 14,425 acres of rangeland and fallow fields was aerially treated to control BLH populations on the west side of Kern, Kings, and Fresno Counties from October 10-15, 1996.

Due to reductions in Russian thistle acreage and slow BLH population development during summer, only one crew was utilized during the treatment campaign. Program personnel and equipment were transported to Kern County on October 9 where a treatment strategy was prepared and final delimitation surveys were performed. The treatments were conducted from south to north, starting in southern Kern County and continued north through Kings and Fresno Counties. On October 10-11, 1996, treatments were conducted in the general vicinity of the Buena Vista basin and Lost Hills. On Saturday, October 12, BLH populations in the Belridge oil fields were treated along with several fields in the vicinity of Lost Hills. Treatments were completed in Kings County on Sunday, October 13 and in Fresno County on Tuesday, October 15.

While clear, sunny weather was encountered during the campaign, treatments were discontinued on several afternoons when temperatures exceeded 80 degrees. A 90-97 percent reduction in BLH populations was ascertained from post treatment surveys performed on a random basis throughout the treatment areas.

BIOLOGICAL CONTROL OF THE BEET LEAFHOPPER

Nine cultures of nine separate species of BLH egg parasites, imported from Iran in 1995, were processed through the quarantine facility at the University of California at Riverside. Applications for the release of all nine species were made to the U. S. Department of Agriculture. The two *Polynema* species were collected from separate locations and were originally believed to represent a single species. Scanning electron microscopy revealed subtle differences between the two and subsequent cross-mating tests established them as separate species.

Cultures of *Gonatocerus* sp. # 3 and *Anagrus atomus* died out in quarantine. Both species did not reproduce vigorously on BLH eggs and may have emerged from other species of leafhopper eggs present in the plant sample from Iran. The seven surviving parasitoid species are listed below:

Mymaridae
1) *Gonatocerus* sp. 1
2) *Gonatocerus* sp. 2
3) *Polynema* sp. 1
4) *Polynema* sp. 2

Trichogrammatidae
5) *Aphelinoidea turanica*
6) *Aphelinoidea anatolica*
7) *Oligosita* sp.

Between December 13, 1995, and September 7, 1996, approximately 24,452 parasitoids introduced from Iran have been released in sugar beets grown at UCR's Agricultural Operations at Riverside, in seven locations in the greater Coalinga area on wild vegetation and in wild vegetation near Hemet. To date, *Oligosita* sp. and *Polynema* sp. have been recovered from sugar beets in Riverside, but none of the seven species have been recovered from BLH breeding areas containing wild vegetation.

BLH egg parasites will continue to be released in an effort to establish all parasite species in wild rangeland vegetation. Follow-up field evaluations will be conducted to ascertain overall effectiveness of the parasites in reducing BLH populations on various rangeland plants and to determine the rate of natural dissemination within rangeland vegetation.

PROGRAM PERFORMANCE

This year, curly top virus infection in susceptible crops was nearly non existent. Surveys of susceptible crops found an occasional infected plant; however, on a state wide basis the infection rate was less than 0.5 percent. The Program constantly stresses weed control to growers and government agencies. The outstanding weed control around fields and along roadsides has undoubtably contributed to the overall successful 1996 control of CTV.

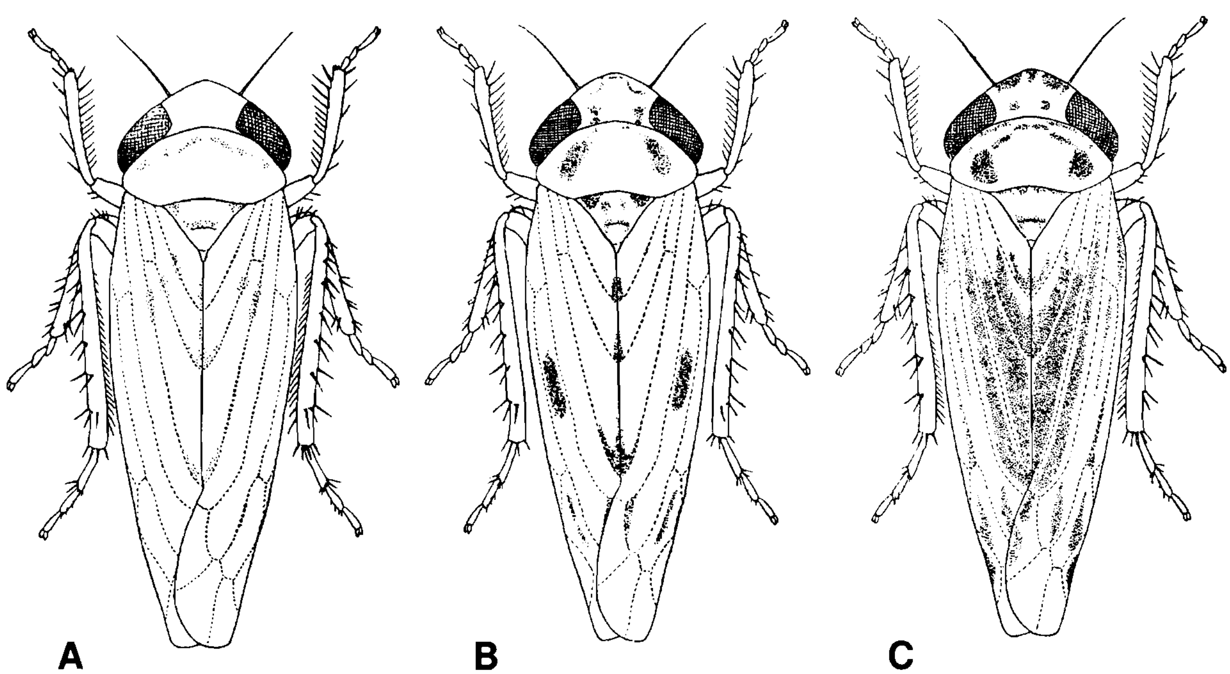


Fig. 3 Adults of the beet leafhopper, illustrating the variation in the intensity of color of individuals produced in different seasons of the year. A: Summer, or light, form. B: Spring, or intermediate, form. C: Winter, or dark, form. All enlarged 20 times. Illustrations taken from W. C. Cook, The Beet Leafhopper. Farmer's Bulletin No. 1886, USDA, 1941.

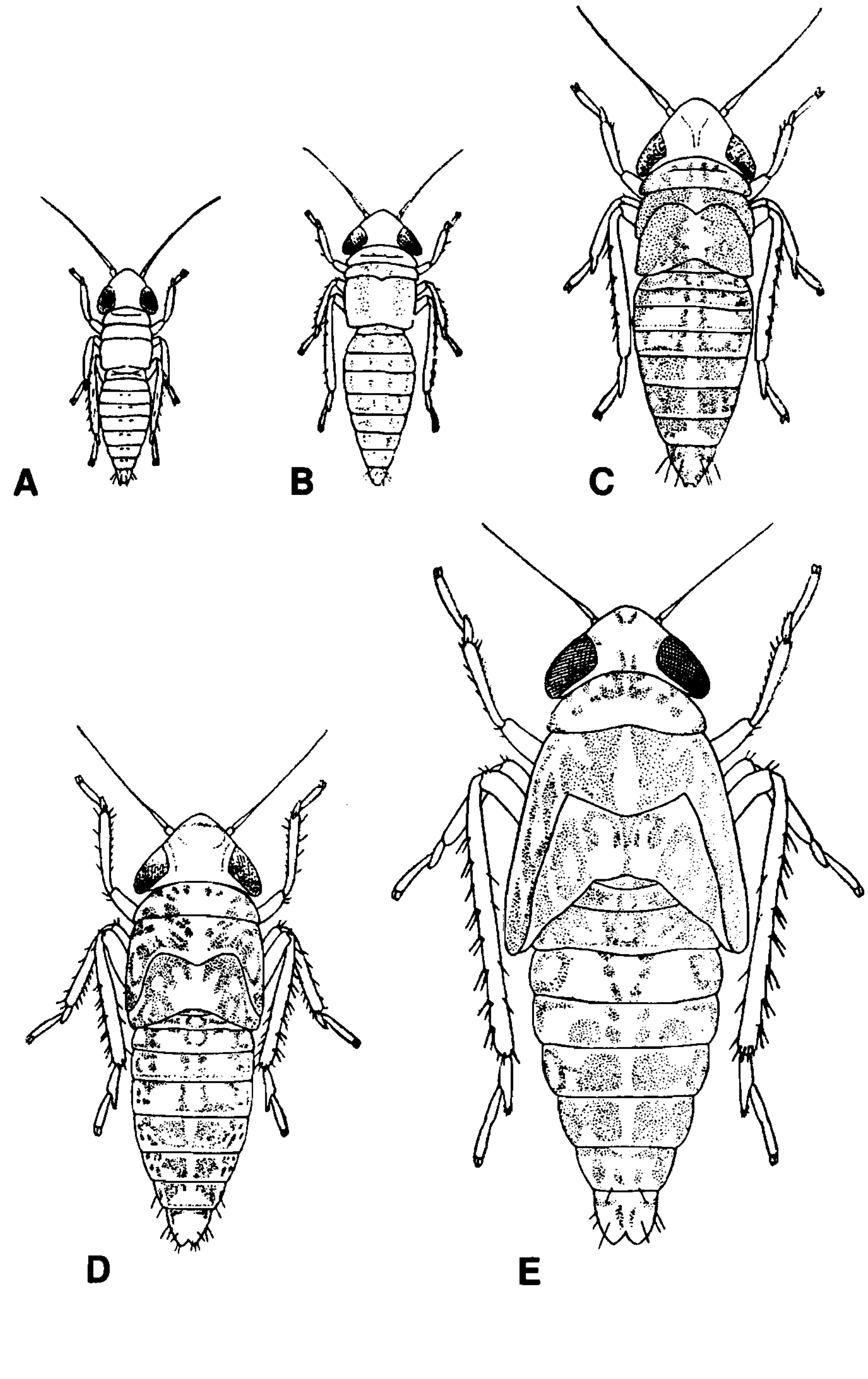


Fig. 4 Nymphal stages of the beet leafhopper. A: First instar. B: Second instar. C: Third instar. D: Fourth instar. E: Fifth instar. All enlarged 20 times. Illustrations taken from W. C. Cook, The Beet Leafhopper. Farmer's Bulletin No. 1886, USDA, 1941.